Maximising self-care through familiarity: The role of practice effects in enhancing music-listening and progressive muscle relaxation for pain management

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Abstract:	Distraction and relaxation are regularly recommended as part of Pain Management Programmes, with increasing research highlighting the inclusion of music as part of pain management toolkit. However minimal research has assessed the role of practice effects or familiarity with these techniques when used consistently over time. Passive distraction (participant-selected preferred music) and active distraction (Progressive Muscle Relaxation; PMR) were compared against a no distraction control on the cold-pressor test (CPT). Seventy healthy participants completed the CPT with and without distraction at baseline and one week later. Experimental participants practised their distraction strategies daily between trials (7 days), with control participants keeping an activity log. Familiarity with and preference for distractors increased significantly over time, enhancing pain threshold. PMR and music reduced anxiety, enhanced pain tolerance, minimised pain perception and pain ratings. The active distraction of PMR enhanced self-efficacy to a greater extent than music and also regulated heart rate. Repeated exposure to distraction and relaxation approaches enhanced optimal arousal and complexity, maximising pain management. It is suggested that both PMR, and music, are used together as part of a multidimensional toolkit for pain management.

Maximising self-care through familiarity: The role of practice effects in enhancing music listening and progressive muscle relaxation for pain management

A cumulative amount of research has demonstrated the positive effects that psychological treatment can have upon pain (see Eccleston et al., 2009 for review). Psychological therapies are a fundamental part of pain management programmes (PMPs), with multimodal biopsychosocial strategies collectively used to improve self-care in patients. Coping methods such as distraction and relaxation are employed alongside approaches which attempt to normalise pain through Mindfulness or Acceptance and Commitment Therapy (Eccleston et al., 2009). Together these methods are used as part of a multimodal pain management 'kit' (Cepeda et al., 2006) and are privileged by their ease of use, minimal side-effects, cost-effectiveness and universal applicability (Eccleston et al., 2002; Cepeda et al., 2006).

Limited capacity models of attention posit that attention is a finite cognitive resource and that the processing of pain signals can be mediated by attentional redirection away from pain and towards absorptive tasks/stimuli (Shiffrin and Schneider, 1977; Verhoeven et al., 2010). Hence pain perception can be minimised if the distractor's attentional demands are of sufficient magnitude. However, the efficacy of distraction may be dependent upon whether it is passive or active (Dahlquist et al., 2007). Active distractors redirect attention through the active involvement of the individual in a task (Windich-Biermeier et al., 2007). They aim to alter the physiological response system to pain, through the lessening of the pain-tension cycle, using techniques such as Progressive Muscle Relaxation (PMR; Jacobson, 1938), jaw relaxation (Good et al., 1999; Schaffer and Yucha, 2004), electronic games (Forys and Dahlquist, 2007) mental arithmetic (Mitchell et al., 2006), and breath therapy (Mehling et al., 2005). Passive distractors redirect attention without active or deliberate involvement (Chambers et al., 2009), for example through watching television (MacLaren and Cohen, 2005), listening to music (Mitchell et al., 2008), or conversation (Zelikovsky et al., 2000). Dahlquist et al (2007) argue that active distraction is more effective than passive distraction due to increased attentional load, modelled biologically through the activation of descending inhibitory pain pathways (Edwards, Campbell, Jamison & Wiech, 2009). There is therefore a significant need to assess the impact of active and passive distractors on pain management. The most commonly recommended approaches are music listening (passive) and progressive muscle relaxation (active; Pain Toolkit, 2012), and these therefore should be priority targets for comparative research.

Multiple-resource theory (Wickens 1984) has provided a theoretical perspective which may explain potential differences between active and passive distractors. Wickens (2008) argued that when multi-sensory attentional resources are used collectively they are more demanding of attention. Distractors may be visual, auditory, spatial or verbal, each viewed in multiple-resource theory as separate attentional stores, giving a prospective rationale for why in pain management multimodal attentional distractors are more absorbing (Wickens, 2008). Johnson et al (1998) investigated Multiple-resource theory and demonstrated that the more processing resources a distractor shares with those of pain perception, the more interference occurs and thus less pain is felt. This theoretical perspective meshes with the established gold-standard recommended in healthcare, a desire for a biopsychosocial model of care (following Engel, 1977), in which biological, psychological and sociological factors involved in the pain experience are valued equally and managed simultaneously.

The level of involvement of the person in their pain management has a significant impact on their self-efficacy: an individual's belief that they are capable to achieve certain levels of performance to control events that affect their lives (Bandura, 1997). Individuals' beliefs regarding their self-efficacy enable human functioning through a number of processes: cognitive, motivational, affective and decision-making (Bandura, 2001). With differential levels of self-efficacy, individuals can self-enhance or self-debilitate. Individuals with high self-efficacy are able to better alleviate stress and anxiety, therefore enabling them to implement better coping strategies. Research suggests that high scores of self-efficacy are inversely related to pain intensity (Borsbo et al, 2010), with findings demonstrating that self-efficacy is a highly accurate predictor of pain-related disability (Sharma et al, 2003) and functioning (Woby et al, 2007). It is possible that active distractors may better initiate increases in self-efficacy than passive distractors, and this may further affect the moderating ability of the pain management technique to minimise pain. Therefore PMR may be more effective than music listening as a result of its promotion of active distraction

PMPs teach the use of distraction/relaxation strategies, and it is expected that these are employed at home, yet research has minimally investigated how repeated use of such strategies can alter their efficacy. Finlay (in press) found that increased familiarity with passive distraction through music, improved patient satisfaction with treatment. Similarly, Mitchell et al (2006) found familiar music reduced pain perception to a greater extent than unfamiliar music. Music was also more effective than other distractors such as art, mathematics or humour (Mitchell et al, 2004; Villareal et al, 2012). Music that is chosen by the participant (preferred music) is also more effective than music provided by the experimenter (non-preferred music), or music chosen by the participant from a pre-prepared experimenter-defined selection (quasi-preferred music; following Hekmat & Hertel, 1993; Mitchell et al, 2006). Investigating PMR, Persson, Veenhuizen, Zachrison & Gard (2008) found regular practice allows the patient to effectively identify the difference between muscular tension and release, therefore promoting self-initiated biofeedback. In addition, repeated exposure to distractors enhances emotional engagement, enhancing adaptive neuroaffective mechanisms useful in pain management (Koelsch, 2010).

Berlyne's (1971) inverted-U theory argues that one's ability to tolerate stimuli is a function of a trade-off between familiarity and complexity, with moderate levels of familiarity and complexity enhancing the efficacy of the stimulus. Potentially therefore, distractors that initiate moderate levels of arousal may be most effective for patients and pain sufferers may choose to continue using these techniques. To date, research comparing active and passive distractors has been limited, and familiarity effects have not been considered. This study aims to explore the role of familiarity in the use of active distraction (PMR) and passive distraction (music), for the management of acute, laboratory-induced pain in a health community-dwelling sample. As music listening and PMR are often recommended as useful for self-care in PMPs (Pain Toolkit, 2012), it is essential that their relative efficacy is investigated in the context of daily, self-initiated use in a home-based environment. The majority of pain self-management occurs in the familial environment, beyond the immediate reach of monitored clinical care and medical attention. It is hypothesised that both active and passive distractors will significantly enhance pain tolerance (the length of time that pain can be tolerated) and pain threshold (the length of time before the first reported onset of pain sensation), and reduce subjective measures of pain intensity during experimental trials. It is expected that regular use/practice of active/passive distraction will also prove beneficial, therefore there will be improvements in all measures after seven days of practice, at week 2. PMR necessitates greater participation during use than music listening as it involves wilful contraction and relaxation of specific muscle groups (de Paula, de Carvalho & dos Santos, 2002). Therefore, it is hypothesised that self-efficacy will be enhanced to a greater extent by PMR than by music listening.

Method

Participants

70 healthy participants completed the full study, both male (N = 31) and female (N = 39). Participants' ages ranged from between 18 to 73 years, (M = 37.50 years; SD = 14.63). All were recruited from a community-based sample from Hertfordshire and Buckinghamshire. Exclusion criteria consisted of diabetes, circulation disorders, smoking, pre-existing pain conditions and claustrophobia due to blindfolding (following Jackson et al, 2005). All participants completed both assessment phases of the research study.

Design

A mixed design was employed, using the between-subjects factor of Group (three conditions); active distraction through Progressive Muscle Relaxation, passive distraction through preferred music listening and a no distraction (silent) control. Participants were randomly assigned to one of the three conditions through a computerised randomisation schedule. Within-subjects factors of Time of Testing (2 levels; Week 1 and Week 2) and Type of Testing (2 levels; baseline and experimental) were used to assess all outcome measures.

Materials

Apparatus

Circulatory Water Bath. A JeioTech circulatory water bath (RW-3025G) was used, which cooled circulating water to 0□. Consistence in water temperature is important for comparable and reliable results (Mitchell et al, 2004). There is a lack of consensus regarding the maximum length of time the hand should be kept in the water. For safety, maximum length of time participants were allowed to keep their hand in the water was 240 seconds (4 minutes; Jackson et al, 2005).

Thermometer. Hand temperature was measured using a digital thermometer (Omron Smart Digital), temperatures being recorded in degrees Celsius.

Music Player. Participant-provided preferred music was played through the music software application iTunes, on a MacBook Pro for all participants. Volume level was self-selected by participants as appropriate to personal taste.

Heart Rate (HR). HR was recorded using an Omron M6 sphygmomanometer. Heart rate is an objective measure of physiological stress induced by clinical context (Thayer, Åhs, Fredrikson, Sollers & Wager, 2009).

Stimuli

Music. Individuals were required to bring with them a chosen piece of music in CD format. Previous findings demonstrate the efficacy in pain reduction of chosen (preferred) music over pre-selected (non-preferred) music by the experimenter (see Mitchell et al, 2006). Chosen tracks were played on the music player (detailed above) during the experimental trials (as appropriate to Group Allocation), without repetition of, adjustment or alteration to the chosen track. All track lengths exceeded the length of time tolerated by participants undertaking the cold pressor test.

PMR. 'Progressive Muscle Relaxation' from the album Guided Relaxation by Edna Reinhardt was used. The track described progressive tightening and relaxing of each set of muscles throughout the body, and the physical feelings associated with the reduction of tension in the body. This PMR track was chosen as there was no background music behind the spoken instructions, ensuring the effect of PMR was being measured and not the effect of music. The track lasted for 8 mins and 37 secs.

Performance Assessments

Pain Threshold. This was calculated as the timespan between participants' immersion of their hand into the water and when they first report experiencing sensations of pain, measured in seconds, using a stopwatch (Duschek et al, 2008). Pontinen (1998) reports that pain threshold is a valid and reliable measure for quantitative evaluation of pain.

Pain Tolerance. This was calculated as the timespan between initial immersion of hand into the water, and when participants withdrew their hand, measured in seconds (following Duschek et al, 2008; Mitchell et al, 2008). Edwards et al (2001) reports that pain tolerance provides a quantitative benchmark for objective evaluation of pain.

Questionnaire Measures

Demographic Questionnaire. A short 4-item demographic questionnaire was used to assess age, gender and educational status. Additionally, one item was used to confirm whether or not the participant was a smoker or not, in accordance with exclusion criteria. Education status was measured by a fixed choice selection of highest qualification achieved (GCSE, AS-level, A-level, Undergraduate, Masters, Doctoral or other equivalent qualification).

Short Form State Trait Anxiety Inventory (STAI): State scale. A six-item scale assessing state anxiety on four-point likert scales, addressing statements such as "I felt calm", "I felt relaxed" was measured using the endpoints strongly agree and strongly disagree. Originally developed by Spielberger (1983), the STAI is a measure of individual differences in anxiety (Taylor & Deane, 2002). It is continues to be widely used in research and applied settings, with literature finding it useful in pain research (Mitchell et al., 2008). The short-form scale has been well-validated and found to be reliable with clinical populations (Marteau & Bekker, 1992).

Numerical Rating Scales (NRS). Five 11-point Likert-type numerical ratings scales were used:

1. *NRS-Pain Perception (NRS-PP).* The NRS-PP utilised the end points 'no pain' and 'extreme pain'. The NRS-PP, as developed by Jensen and Karoly (2001) is endorsed by The British Pain Society, and has been used in numerous studies (e.g. Gustavsson & von Koch, 2006).
2. *NRS-Current Pain Intensity (NRS-CPI).* The NRS-CPI is a variation of the NRS-PP, but with the wording altered to reflect a demographic assessment of baseline pain at the present time at the outset of the research study. This was used as a between-groups screening tool, and is validated and used as the NRS-PP.

3. *NRS-Efficacy of Distraction (NRS-EOD).* The NRS-EOD contained end points ‘not at all’ and ‘completely’, following the statement “I felt able to take my mind off the pain”. The EOD has been effectively used in previous pain research (Mitchell et al, 2008).
4. *NRS-Familiarity (NRS-P).* The NRS-F was used to assess level of familiarity with the musical selection used by the participants in weeks 1 and 2. The selected end-points were ‘not at all familiar’ and ‘extremely familiar’.
5. *NRS-Preference (NRS-F).* The NRS-P was used to assess level of preference for the musical selection chosen by the participants. The end-points ‘not at all liked and ‘extremely liked’ were included to anchor the scale.

Short Form McGill Pain Questionnaire (SF-MPQ; Melzack, 1983). Fifteen pain descriptors (11 sensory; 4 affective) were measured using a 4-point Likert scale, where 0 = none, 1 = mild, 2 = moderate and 3 = severe. Total Pain Score (TPS) was used as a principal measure, with subscales for sensory and affective pain. The SF-MPQ has been used in previous literature, showing reliability and validity (Katz & Melzack, 2011).

The General Self-Efficacy Scale (GSE). Ten items were measured using the representative end points ‘not at all true’ and ‘exactly true’. Item scores are totalled to yield an overall score ranging from 10-40: the higher the score, the greater the perceived self-efficacy. Developed by Schwarzer and Jerusalem (1995), the GSE has been used internationally and is accepted to be highly reliable.

Procedure

Participants willing to take part in the study were recruited through advertisements in the local community and given an instruction booklet outlining what their participation would require. Participants were also asked if they were happy to be blindfolded, to ensure visual distraction did not occur, and were given the opportunity to ask questions about the research. Those willing to continue were screened against the exclusion criteria and asked to provide written, informed consent. Once participants had agreed to take part, they were allocated to one of the three conditions. Participants allocated to the music group were asked to bring with them a chosen piece of music, and were reassured that their musical taste was not under examination and they could chose any music that they felt they would enjoy listening to.

Following recruitment and consent, participants were asked to complete all questionnaire/NRS assessment measures to provide baseline scores. From time of consent to the conclusion of the experiment, all further interactions with participants were scripted to minimise any influence of the presence of the experimenter and to ensure that the repeated cold pressor tests (at weeks 1 and week 2) were comparable (following Saab et al., 1993). Firstly, a week 1 baseline trial was completed. Participants were seated next to the cold pressor bath, asked to remove any jewellery from their right arm, they were then blindfolded and the sphygmomanometer attached to their left arm. Participants were asked to submerge their right hand in the water and to give a verbal indication of when they first felt pain, and pain tolerance was monitored by stopwatch. Immediately on withdrawal of the hand from the water, participants' completed the NRS measures (excepting the NRS-CPI baseline assessment), STAI, SF-MPQ and their HR was recorded. The participant's hand was then allowed to return to baseline temperature and recovery time was provided.

The cold pressor test was next repeated as a week 1 experimental trial. According to group allocation, participants listened to music, used progressive muscle relaxation or had no distraction during the course of their experimental trial. Pre- and post-test measures were taken as before. After completion of the experimental cold pressor test, participants in the music listening and PMR groups were asked to listen/practice their distraction every day (1-6) and were provided with a CD of the PMR where appropriate. Participants were asked to focus on their music/PMR and to refrain from doing other tasks whilst listening to their music or PMR CD during the practice days. From days 1-6 participants tracked their levels of familiarity with their distraction, daily pain ratings, and their preference for the music/PMR through a personal information booklet. Practice was considered to be completed if participants had listened to their chosen musical selection or the full PMR CD (approx. 8mins). Control group participants completed a short reflection activity, diarising the content of their day in the information booklet.

Participants returned at day 7 (week 2), again completing two cold pressor tests - at baseline and with distraction as appropriate to their grouping. The same measures were taken as at Week 1. At the completion of the study, all participants were debriefed and asked to give feedback regarding the experiment.

Ethics

This research met all standards of the British Psychological Society and the University of Buckingham granted ethics approval. Participants were informed that data would remain anonymous, and they could withdraw from the study at any stage, with data being discarded immediately. The cold pressor test has been found to cause short-term laboratory-induced pain (Saab et al., 1993), with no lasting effects, and no long-term damage, where exclusion criteria (listed above) are upheld. Participants were told prior to starting the experiment that they could remove their arm at any stage during the test. Participants were asked to remove their arm if they remained in the cold pressor for the full four minutes.

Statistics and Analysis

The primary measure outcomes were Tolerance and Threshold (measured in seconds). Secondary measure outcomes were Anxiety, Pain Perception Ratings (NRS-PP), Total Pain Score (TPS; obtained from the SF-MPQ), Self-efficacy (obtained through the GSE and NRS-EOD) and Heart Rate, used as physiological measure of pain impact. Statistical analysis was carried out using SPSS v. 20.

The following analyses were computed to investigate between group differences at baseline: a one-way ANOVA (3 levels; music, PMR and control) on age; and chi-square analyses on the outcome measures of Level Of Education and Gender. Paired samples *t*-tests were undertaken for music and PMR groups, comparing preference and familiarity at week 1 and week 2.

To investigate the impact of familiarity and preference on between group performance the following were computed: repeated-measures ANOVAs were computed to determine the impact of Group, Week Of Testing and Type Of Testing on all outcome variables. To assess Heart Rate, an ANCOVA was computed, with preliminary baseline HR used as a covariate.

Results

Internal Consistency, Validity, Normality

Cronbach's alpha was used to assess internal consistency, with results demonstrating high internal consistency in all standardised questionnaire outcome measures (GSE α = .94; SF-MPQ α = .87; STAI α = .88). These results were within the recommended ranges for the standardised questionnaires: GSE, α = .76 - .9 (Schwarzer & Jerusalem, 1995); SF-MPQ α = .73 - .89 (Burckhardt & Bielle, 1994); STAI α = .85 - .95 (Tanaka-Matsumi & Kameoka, 1986). To assess normality of results, outcome measures were assessed using Kolmogrov-Smirnov test. As results attained significance, Greenhouse-Geisser adjustments were used in all further analyses.

Between-Group Comparability

To assess comparability between Groups (Control, Music or PMR) at baseline, one-way ANOVAs were used. All groups were comparable in age ($F(2, 69)=.48$, $p = .62$) and current pain intensity (NRS-CPI; $F(2, 69)=1.71$, $p = .19$) at baseline. Results from chi-squared analyses also showed that Groups were comparable in gender distribution ($\chi^2 = 3.21$, df = 2, $p = .2$) and educational levels ($\chi^2 = 3.21$, df = 2, $p = .2$).

Familiarity and Preference

Mean familiarity significantly increased from week 1 to week 2 for both Music ($t(23) = -5.3$, $p < .001$) and PMR ($t(22) = -41.1$, $p < .001$), as shown in Table 1. Mean preference showed the same pattern, increasing by week 2 for both Music ($t(23) = -4.1$, $p < .001$) and PMR ($t(22) = -42.4$, $p < .001$).

Insert Table 1: *Mean Outcomes of Familiarity and Preference for Music and PMR Distractors.*

Primary Outcome Measures

Pain Tolerance. A significant interaction between Type of Trial and Group was found, with experimental trials inducing significantly greater pain tolerance than baseline trials (F(2,67)= 9.1, p < .0001, p^2= .23), and with the music (p < .0001) and PMR (p < .001) groups showing significantly greater improvements over the control group (see Figure 1). A significant main effect of Type of Trial was found (F(1, 67) = 38.77, p < .001, ηp^2=.37), with experimental trials improving pain tolerance for all participants. Similarly, a significant main effect of Week Of Testing was found (F(1,67)= 12.36, p < .001, ηp^2= .16) with mean tolerance at week 2 significantly higher than mean tolerance at week 1. Descriptive Statistics for all outcome measures are contained in Table 2.

Insert Figure 1: The influence of week of testing and type of trial on pain tolerance

*Pain Threshold***.** There was a significant interaction between Type of Trial and Group (F(2, 67) = 4.13, p < .05, ηp^2= .11). Post-hoc tests revealed that the PMR significantly enhanced pain threshold over control (p < .05), but there was no benefit of music over control or difference between PMR and Music listening (see Figure 2). A significant main effect of Week of Testing was found (F(1,67)= 11.14, p < .001, ηp^2=.14), with mean threshold enhanced at week 2 over week 1. Experimental trials also enhanced pain threshold over baseline trials (F(1,67) = 27.71, p < .0001, ηp^2= .13), with a significant main effect of Group allocation (F(2,67) = 3.63, p < .05, ηp^2= .10).

Insert *Figure 2:* The influence of week of testing and type of trial on pain threshold

Insert Table 2: *Mean and Standard Deviations for Week of Testing (week 1 vs. Week 2) and Type of Trial (Baseline and Experimental), for Control, Music and PMR Groups, on Outcome Variables.*

Secondary Outcome Measures

Anxiety. A significant interaction was found between Week of Testing and Type of Trial ($F(1, 67) = 8.98$, $p < .005$, $\eta p^2 = .12$), with mean anxiety for all participants showing the greatest reduction after the experimental trial in week 2. Results also showed that there was a main effect of Group ($F(1, 67) = 4.16$, $p < .05$, $\eta p^2 = .11$), with the PMR group showing significantly lower anxiety ($p < .05$) than the control group, and a trend towards an advantage for the music group over control ($p = .06$), but with no difference between the music and PMR groups. No further main effects were shown.

Pain Perception Rating (NRS-PP). Though no overall main effect of Group was found ($F(1, 67) = .455$, $p = .64$, $\eta p^2 = .01$), an interaction was found between Week of Testing and Group ($F(2, 67) = 11.40$, $p < .001$, $\eta p^2 = .25$) and between Type of Trial and Group ($F(1, 67) = 4.92$, $p < .01$, $\eta p^2 = .13$) with experimental groups broadly showing greater reductions than controls in Week 2 in experimental trials (3-way interaction: Group, Week of Testing, Type of Trial: ($F(2, 67) = 3.34$, $p < .05$, $\eta p^2 = .09$). Week of Testing significantly influenced Pain Perception Ratings, with scores at Week 1 significantly higher than those at week 2 ($F(1, 67) = 10.76$, $p < .01$, $\eta p^2 = .01$).

A main effect of Type of Trial was also shown ($F(1, 67)=57.91$, $p < .001$, $\eta p^2= .24$), with experimental trials reducing pain perception in comparison to baseline trials.

Total Pain Score (TPS). No significant main effect of Week of Testing was found, however there was a significant interaction between Week of Testing and Group ($F(2,67) = 10.53$, $p < .0001$, $\eta p^2=.24$), with both the music and PMR groups showing reduced pain scores at week 2 in comparison to the control group. A significant interaction was also found between Week of Testing and Type of Trial ($F(1, 67) = 17.02$, $p < .0001$, $\eta p^2= .20$), with experimental trials in Week 2 showing the greatest Total Pain Score reductions. No further main effects were found.

Self-efficacy. No significant main effect of Week Of Testing was found ($p=.52$), however a significant main effect of Group was found ($F(2,67) = 7.83$, $p < .001$, $\eta p^2=.19$), with post-hoc tests revealing that self-efficacy scores when listening to music were significantly greater than those of the control group ($p < .001$), as were those of the PMR group ($p < .05$). Music and PMR showed different patterns, however, with a trend towards the greatest self-efficacy for the music group shown in week 1 and for the PMR group shown after practice and familiarity with the technique, at week 2 ($F(2, 67) = 2.65$, $p = .078$, $\eta p^2=.07$). A significant main effect of Type Of Trial was found ($F(1,67)= 49.5$, $p < .001$, $\eta p^2= .06$), with mean self-efficacy scores increasing during experimental trials compared to baseline trials, however no main effect of Group was found ($p=.25$; See Figure 3). No further interaction effects were shown.

Insert *Figure 3:* The effect of Week of Testing on Self-efficacy

Heart Rate. There was no significant impact of baseline HR on subsequent HR during any further trials, since the covariate was found to be non-significant, p =.11. No significant main effect of Week of Testing was found (p = .51), however a significant main effect of Group was found ($F(2,66) = 3.3$, $p < .05$, $\eta p^2 = .09$). Post-hoc analysis revealed a significant difference between PMR group HR and control HR ($p < .05$), with PMR HR decreasing over time and control HR increasing over time. No further main effects or interactions were found.

Discussion

This study aimed to investigate whether active and passive distractors had differential effects in reducing individuals' perceptions of pain and associated symptoms, in the context of increased familiarity with and preference for the distractors. Results showed that asking experimental participants to practice PMR or to listen to their chosen music daily did significantly enhance participants' preference for and familiarity with the distraction techniques. Both groups showed comparable increases in liking and familiarity. Asking participants to familiarise themselves with their pain management technique was beneficial in enhancing pain control, with PMR delaying the onset of pain by increasing the time before participants first reported pain (pain threshold). Similarly, both music and PMR enabled participants to tolerate pain for longer than when exposed to pain with no distraction.

PMR was privileged over music in its ability to reduce anxiety, with anxiety at its lowest at week two after participants had increased familiarity with the pain management techniques. Music also reduced anxiety, but to a lesser extent than PMR, suggesting that both active and passive distractors have a positive anxiolytic effect in the context of laboratory-induced pain.

Both Music and PMR enhanced self-efficacy over no pain management intervention, however familiarity with music listening decreased self-efficacy by week two, whereas familiarity with PMR increased self-efficacy, showing that practice was beneficial for PMR but not for preferred music. Pain perception was also modestly influenced by distraction, with both PMR and Music groups showing decreased pain perception ratings in the second week of testing, when employing their active or passive intervention. Total Pain score, similarly showed a similar pattern, with interventional group participants reporting reduced pain at week two in comparison with the control group. The role of distraction in pain management was also modelled physiologically, specifically for the PMR group, with Heart Rate reduced when the active distraction was employed, whereas the control group showed an increase in Heart Rate. Overall, these results demonstrated that active and passive distractors did influence experimentally-induced pain in differing ways. PMR reduced anxiety, pain perception, total pain score and HR, and increased pain tolerance and pain threshold. Importantly, repeated exposure to PMR enhanced locus of control by increasing participants' self-efficacy. Music also reduced anxiety, but to a lesser extent, and did not impact physiologically on Heart Rate. However, music listening did enhance pain tolerance, pain threshold, reduce pain perception and total pain score. Music, as an already familiar preferred distractor, did not enhance self-efficacy after repeated exposure despite preference for the music and familiarity with the music increasing after regular listening.

Results demonstrated that listening to music and practicing PMR each day for a week, did increase individuals' preference for and familiarity with both distraction approaches. These results are concordant with previous research; increased exposure to distractors results in improved ratings of familiarity (Schellenberg, 2008). It is possible therefore, that the short-term longitudinal profile of this research served to enhance the arousal potential of music and PMR in line with Berlyne's (1971) inverted-U theory, with the arousal potential being of significant magnitude to affect psychological and (for PMR) physiological markers of pain. However, in some aspects, music was less effective than PMR, and this requires further explanation. Heyduk (1975) proposed the optimal complexity model, which suggested that individuals will prefer stimuli fitting with their perception of optimal complexity, rather than stimuli that they consider to be too complex, or not complex enough. Repeated exposure to distractors increases familiarity, which in turn potentially decreases the distractor's perceived complexity. This could be extended to explain the findings in relation to anxiety modulation, self-efficacy, and Heart Rate, in which music listening was less effective: results suggested that familiarity and preference were reaching optimum for preferred music listening in week one and for the unfamiliar PMR in week two. As the music was self-selected by participants, this may already have been at or near the peak of optimum arousal, therefore with repeated hearings its arousal potential and efficacy as a distractor waned. Whereas PMR's arousal potential improved with regular practice by week two. Further research could broaden the length of longitudinal follow-up to firmly establish at which point, if any, perceived complexity of active and passive distraction peaks and then wanes, therefore reducing its efficacy as an analgesic. Whilst these results would suggest that efficacy of music and PMR distractors increase over a week-long trial, long term effects need to be tested, in order to further apply to a long-term clinical population of chronic pain sufferers.

Increased familiarity and preference for music and PMR, through listening and practice were found to delay pain threshold and increase pain tolerance (though to a lesser extent). With regard to PMR, Persson et al (2008) state that for the intervention to work effectively, regular practice needs to be undertaken. Repetitive practice of PMR allows the patient to quickly and effectively learn to identify the difference between muscle tension and muscle release, therefore enabling them to acquire perceptual calmness and maintain muscle relaxation (Persson et al, 2008). Concerning music, Mitchell et al (2006) found greater efficacy for the use of familiar music for reducing perceptions of pain, than for unfamiliar music. Therefore, as music familiarity was rated greater during week two testing than week one, it is appropriate that pain threshold and tolerance increased over time. With increased familiarity with music, emotional engagement is also found to rise (Silva-Pereira et al, 2011), this shown to be influential in the enhanced efficacy of emotionally-salient music as a reliever of pain (Villarreal et al, 2012). The different findings in self-efficacy between music and PMR could potentially be explained by the emotional valence of the distractor. Music, as a preferred selection, is likely to already hold emotional relevance, whereas PMR may develop emotional salience with increasing practice and recognition of psychophysiological benefits.

Such emotional salience is potentially both positive and negative. Though some research has shown positive effects of preferred (emotionally-salient) music (e.g. Mitchell & MacDonald, 2006), pain theory suggests emotional processing of distractors could be detrimental. Leventhal et al (1983) proposed the parallel process theory of pain, which consists of two competing components; the informational and the emotional mechanisms. The informational module encompasses sensory facets of the physical stimulus, whereas the emotional module comprises feelings such as fear and anxiety. According to Leventhal and colleagues, an individual will feel pain proportional to the amount of attention placed on the emotional component of the stimulus, rather than the informational component; if something is processed emotionally, it will lead to greater perceptions of pain (Broucek & Bartholomew, 1993). Broucek and Bartholomew (1993) state that the role of distraction is to help the individual to ignore the affective response to the painful stimulus. Due to the highly emotional aspect of music, using this technique may fail to allow the individual to ignore the affective component of the painful stimulus, due to this system being highly activated whilst listening to music. It could be that PMR has a greater effect on the informational component of the painful stimulus, and therefore, for individuals in the PMR group, pain was not processed emotionally, leading to reduced perceptions of pain. Further research could consider the emotional aspect of distractors on individual's perceptions of pain, and consider whether there is an optimum level of emotional engagement needed in order for the greatest efficacy of distractors to be obtained. Research needs to consider the impact that emotional engagement has over both music and PMR, and the influence this has on perception of pain.

The anxiolytic properties of both music listening and PMR found in this study have been demonstrated in previous research. Relaxation techniques have commonly been found to reduce individuals' levels of anxiety, with distraction/relaxation procedures easily grasped, undertaken and managed by patients (Seers & Carroll 2001; Kristine et al, 2006). According to Wong et al (2010), during relaxation, the individual feels that they can exercise control over the painful stimulus, resulting in threat reduction, and therefore, reducing anxiety levels. Leubbert et al. (2001) suggest that increased anxiety results in an increase in muscle tension, which in turn leads to an increased perception of pain. Therefore, through reducing muscle tension and anxiety, perceptions of pain should also be reduced. The fact that PMR had a stronger anxiolytic effect may be due to the active element of the technique allowing the individual to feel that they are instrumental in controlling their perceptions of pain. This concurs with the findings regarding self-efficacy, where regular practice of PMR enhanced locus of control to a greater extent than music listening. According to Roykulcharoen and Good (2004), distraction/relaxation can be implemented as a coping strategy that can enable the individual to feel they can govern the pain; thus increasing self-efficacy. Zusman (2005) states that the valuable effects of enhancing self-efficacy of chronic pain patients in a clinical setting are commonly noted in current literature, with findings consistently demonstrating that increasing levels of self-efficacy reduce individual's levels of pain (Keefe et al, 2004). Mastery experiences, which are gained through performance accomplishments, have been found to have the greatest influence on creating and reinforcing individuals' self-efficacy (Turk & Okifuji, 2002). In fitting with this theory of mastery experiences, as individuals practiced their PMR each day, they may have felt as though they were accomplishing set tasks, thus increasing their levels of self-efficacy. Through daily practice, individuals were likely to experience high levels of performance accomplishments. Increase in preference and familiarity for music was found to reduce levels of self-efficacy, and this may be due to the passive task leaving individuals lacking in mastery experiences. Music listening facilitates reduced anxiety as participants have control in selecting their own distractor, but as it is already familiar and requires no additional learning and is therefore passive, the additional activity required by It is possible that future research could allow participants to self-select music for individually perceived biopsychosocial benefits as appropriate to their daily needs, therefore enhancing the active component of music and enabling familiar music to become more active in its distractive properties. In the same way, it may be argued that the multi-dimensional nature of music and music listening processes may be conferring additional benefits upon the listener, in a more active way than may originally appear. Future research could aim to investigate the extent to which participants are immersing themselves in potentially active components of music listening, such as analysis of the instrumentation, recognition of compositional patterns, and communication through lyrics. Think-aloud protocols could be used to assess the extent to which preferred music may be initiating enhanced self-efficacy, though to a lesser extent than PMR. in its psychological impact. Self-efficacy is a variable that should not be underestimated in pain management as heightened beliefs of self-efficacy are directly related to patients' willingness to continue with pain management, regardless of potential difficulties that they may face (Turk, 2004).

The current results demonstrate that PMR has a positive effect on reducing individuals' heart rate, whereas music listening does not. This negative finding for music does not fit with previous research, such as that by Mimi et al (2005), who found individuals who listened to relaxing music had lower heart rates compared to controls. Similarly, research by Tse, Chan & Benzie (2005) and Cadigan et al (2001) found that music listening regulated or reduced heart rate intra-operatively and post-operatively. The ability to lower heart rate is important in a pain management context: Reeves and Shapiro (1983) found that individuals who were able to lower their heart rate demonstrated lower levels of pain perceptions during a cold pressor task. Yet more recent suggested that an increase in heart rate can enhance pain tolerance through activating fight or flight responding, for example when people swear in response to pain (see Stephens & Umland, 2011). As music enhanced pain tolerance, it may be that the increase in heart rate was positive for these participants. However, interestingly, the opposite effect was modelled with PMR and PMR showed enhancements in pain threshold in addition to pain tolerance. This may suggest that reducing heart rate (e.g. through active distraction) could have greater concomitant analgesic effects than increasing heart rate (e.g. through passive distraction). Future research could target Heart Rate as a primary outcome measure to assess this. has demonstrated that However additional research could explain why Heart Rate was elevated in response to music listening in this study: Kenntner-Mabiala et al (2007) found that music of fast, moderate or slow tempi affected pain perception in different ways. Music with a fast tempo increased Heart Rate, respiration rate and arousal, therefore its regulatory and analgesic effect was poor. It is possible that in the current study, music chosen by participants was variable in tempo and chosen for a variety of different reasons, for example for its uplifting properties or high emotional significance, resulting in a greater affective component and therefore, physical components of the painful experience, such as heart rate, were not impacted. Further research could investigate requesting that participants provide music of different tempi to investigate the interruptive function of musical constructs on physiological markers of arousal and pain.

The current research is limited by its inclusion of healthy community-dwelling volunteers, and it would be useful to extend the trial to chronic pain sufferers who have been recommended relaxation/distraction techniques as part of a pain management programme. An increased sample size and clinical population would further establish the efficacy of active and passive approaches recommended by pain management services. The duration of this study was limited to one week, and whilst promising results were found, its applicability to chronic pain is limited by its short-term longitudinal profile. Chronic pain is, by definition considered to be benign or progressive pain extending beyond 12 weeks, therefore it is essential to assess whether distractors have a lasting impact over longer time periods (The British Pain Society, 2012). In addition, this experimental study showed that all participants improved in psychological markers of pain between week one and week two of testing. It is likely that because participants have already undertaken the cold pressor test during week one, their previous encounter with the painful stimulus may have had a natural effect on reducing anxiety and pain perception, therefore memory for pain is contributing to these results. it has been noted that pain-inhibitory systems are influenced by memory processes (Flor, 2003), therefore research could further consider the relationship between memory and inhibition of pain, and question whether prior exposure to a painful stimuli causing the participant to effectively cope with pain may in some instances have a positive effect.

This research intended to consider the efficacy of active and passive distractors on individuals' perceptions of pain. Overall findings would suggest that active distractors, such as PMR, are more effective at reducing individuals' perceptions of pain than passive distractors (following Villarreal et al, 2012). These results reflect the concepts of multiple resource theory of attention (Wickens, 2002). Wickens (1984) argued that active and passive distractors are more or less effective as a result of the number of multi-sensory attentional resources that they occupy. Distractors that work best are those that saturate a number of attentional stores (e.g. auditory and spatial) as in the case of active distraction PMR, and to a lesser extent for passive distraction through music. Current literature suggests that a multidimensional approach towards pain management appears to have the greatest and most positive efficacy in reducing perceptions of pain (Turk & Okifuji, 2002). The positive effect of both music and PMR suggest that it would be appropriate to combine both active and passive distractors, as a holistic tool kit for pain management.

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Figure 1: The influence of week of testing and type of trial on pain tolerance

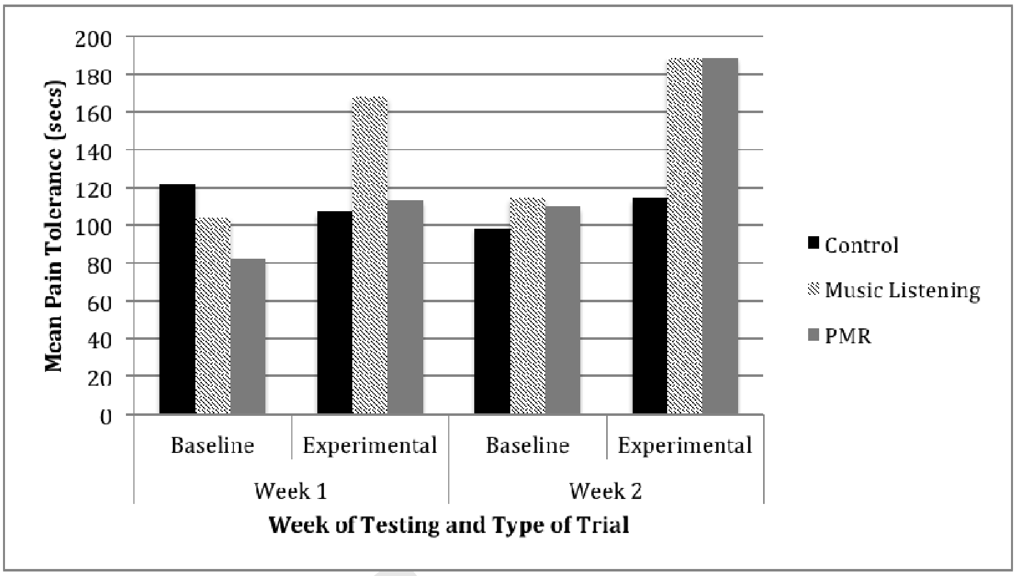

Figure 2: The influence of week of testing and type of trial on pain threshold

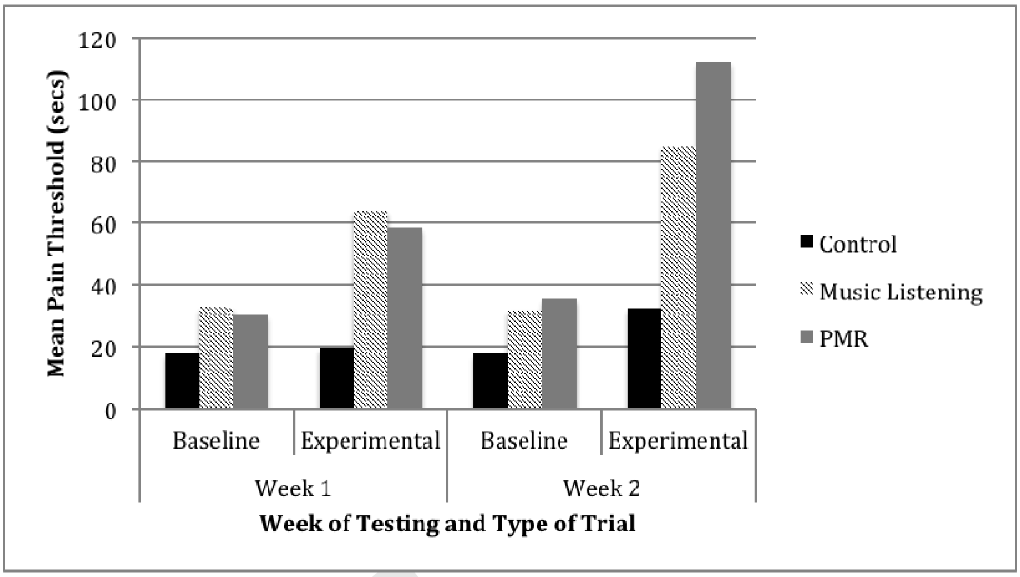

Figure 3: The effect of Week of Testing on Self-efficacy

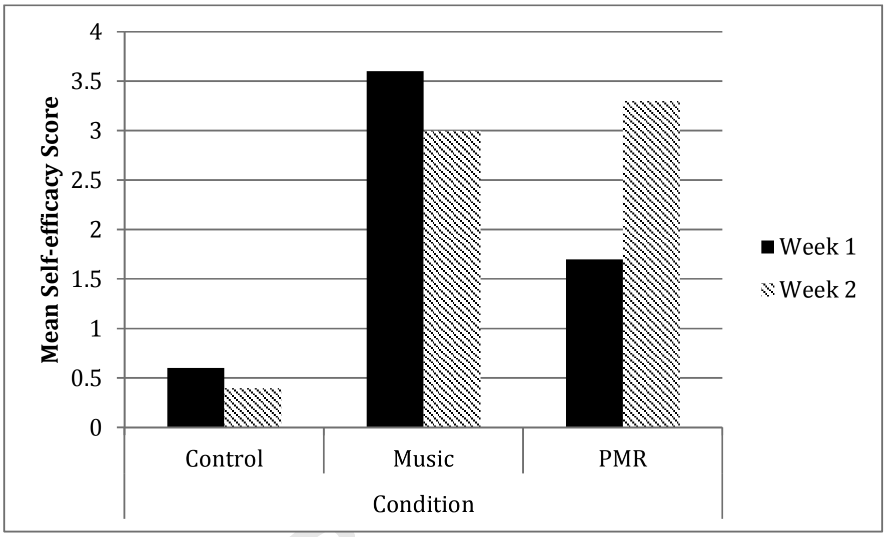

Table 1

	Familiarity		Preference	
	Week 1	Week 2	Week 1	Week 2
Music	6.8 ± 1.4	8.8 ± 1.0	7.3 ± 1.3	8.8 ± 1.1
PMR	0.6 ± 0.8	9.4 ± 0.7	1.1 ± 0.6	9.1 ± 0.7

Table 2

		Control				Music				PMR				*p*-values	
		Week 1		Week 2		Week 1		Week 2		Week 1		Week 2		Week of Testing	Type of Trial
		B	E	B	E	B	E	B	E	B	E	B	E		
Threshold	M	17.74	19.61	17.57	32.39	32.71	64.90	31.88	84.88	30.26	58.70	35.43	112.00	<.0001	<.0001†
	SD	11.75	17.10	16.91	65.75	55.66	88.60	53.75	96.76	48.35	73.83	47.13	97.06		
Tolerance	M	122.43	107.39	98.70	114.39	104.13	167.96	114.50	188.79	82.65	113.22	109.65	188.74		†
	SD	99.82	93.24	87.81	93.92	91.68	97.25	95.67	88.67	86.71	95.54	90.39	85.34		
Anxiety	M	20.22	21.04	19.22	18.96	17.71	18.25	18.63	17.17	18.17	17.43	18.61	16.61	<.05	<.05
	SD	3.47	4.27	3.55	3.21	3.14	2.49	4.16	4.29	3.75	4.07	3.06	2.71		
NRS-PP	M	5.13	5.43	5.07	4.30	5.75	4.54	6.71	4.46	5.89	6.52	5.91	3.74	†	
	SD	2.28	2.50	2.36	2.49	2.01	2.48	2.26	3.08	1.90	2.02	2.02	2.16		
Self-efficacy	M	5.39	5.96	5.70	6.13	4.33	7.92	4.33	8.29	3.91	5.57	4.52	7.70	<.01	
	SD	3.23	3.01	2.98	3.20	3.36	2.26	2.75	1.73	2.64	2.45	2.84	2.67		
HR	M	67.52	68.22	65.70	68.83	72.67	71.63	74.82	70.88	71.78	68.57	70.00	66.22	<.05	<.05
	SD	9.97	11.27	8.14	10.47	12.76	14.67	13.37	9.82	16.39	10.00	12.34	9.56		
TPS	M	7.65	8.30	6.22	5.09	5.71	5.42	9.00	6.13	8.09	9.52	8.26	6.39	†	

SD	4.89	5.46	3.25	3.07	4.54	4.18	8.82	6.07	4.03	5.18	5.60	4.39

Table 1: *Mean Outcomes of Familiarity and Preference for Music and PMR Distractors. Results shown as mean ± standard deviation.*

Table 2: *Mean and Standard Deviations for Week of Testing (week 1 vs. Week 2) and Type of Trial (Baseline and Experimental), for Control, Music and PMR Groups, on Outcome Variables. Between-Groups differences are shown as * p<.05; ** p<.01; *** p<.001; Interactions with Group are shown as †.*